

National Aeronautics and Space Administration



Astrophysics

APD Update and Q&A

Paul Hertz

Astrophysics Subcommittee

November 6, 2012

www.nasa.gov



Credit: NASA



Credit: Marty Harris/McDonald Obs./UT-Austin

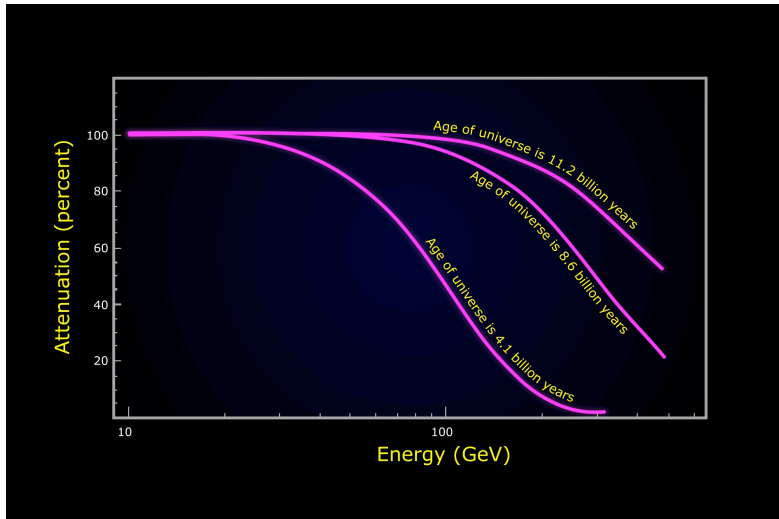
- Evidence of a planet's destruction by its aging star has been found by an Intl team of astronomers.
- The missing planet was devoured as the star began expanding into a red giant.
- Evidence includes:
 - the star's peculiar chemical composition (Abnormally high Li); and
 - the highly unusual elliptical orbit of its surviving planet.

This research was funded by the Origins of Solar Systems (OSS) program element of the Astrophysics Research Program

M. Adamow, A. Wolszczan, et al., Ap.J., 754:L15 (2012)



Cosmic ‘Fog’ Produced by Ancient Starlight is Measured



Fermi measured the amount of gamma-ray absorption in blazar spectra produced by ultraviolet and visible starlight at three different epochs in the history of the universe.

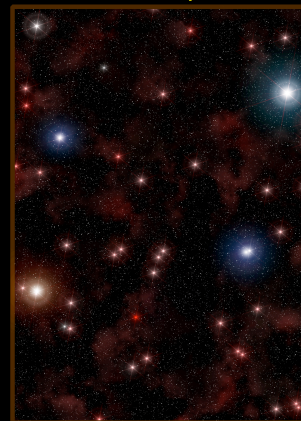
From this measurement, scientists were able to estimate the fog's thickness. To account for the observations, the average stellar density in the cosmos is about 1.4 stars per 100 billion cubic light-years, which means the average distance between stars in the universe is about 4150 light-years.

- Scientists studied gamma-ray signals from 150 strongly detected blazars.
- Gamma rays produced in jets travel across billions of light-years to Earth, and some will interact via inverse-Compton on ambient visible and UV light emitted by stars that formed throughout the history of the universe.
- More distant blazars show fewer gamma rays at higher energies, especially above 25 GeV, thanks to absorption by the cosmic fog. The farthest blazars are missing most of their higher-energy gamma rays.

The Cosmic Goldilocks Problem

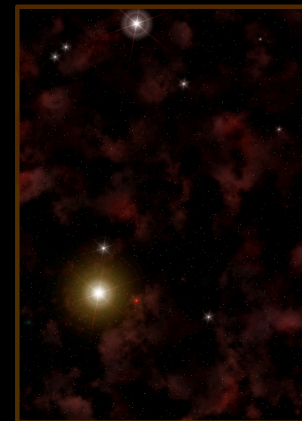
EBL informs us about the number of stars in the universe

Too many



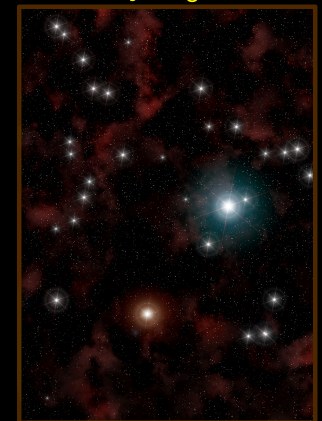
2.8

Too few



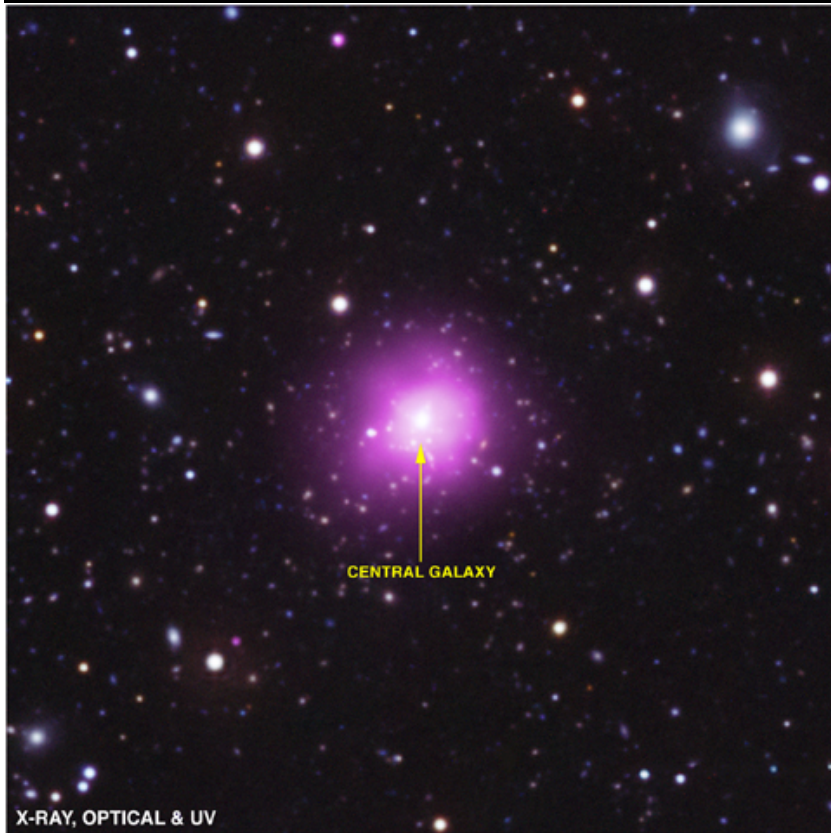
0.7

Just right

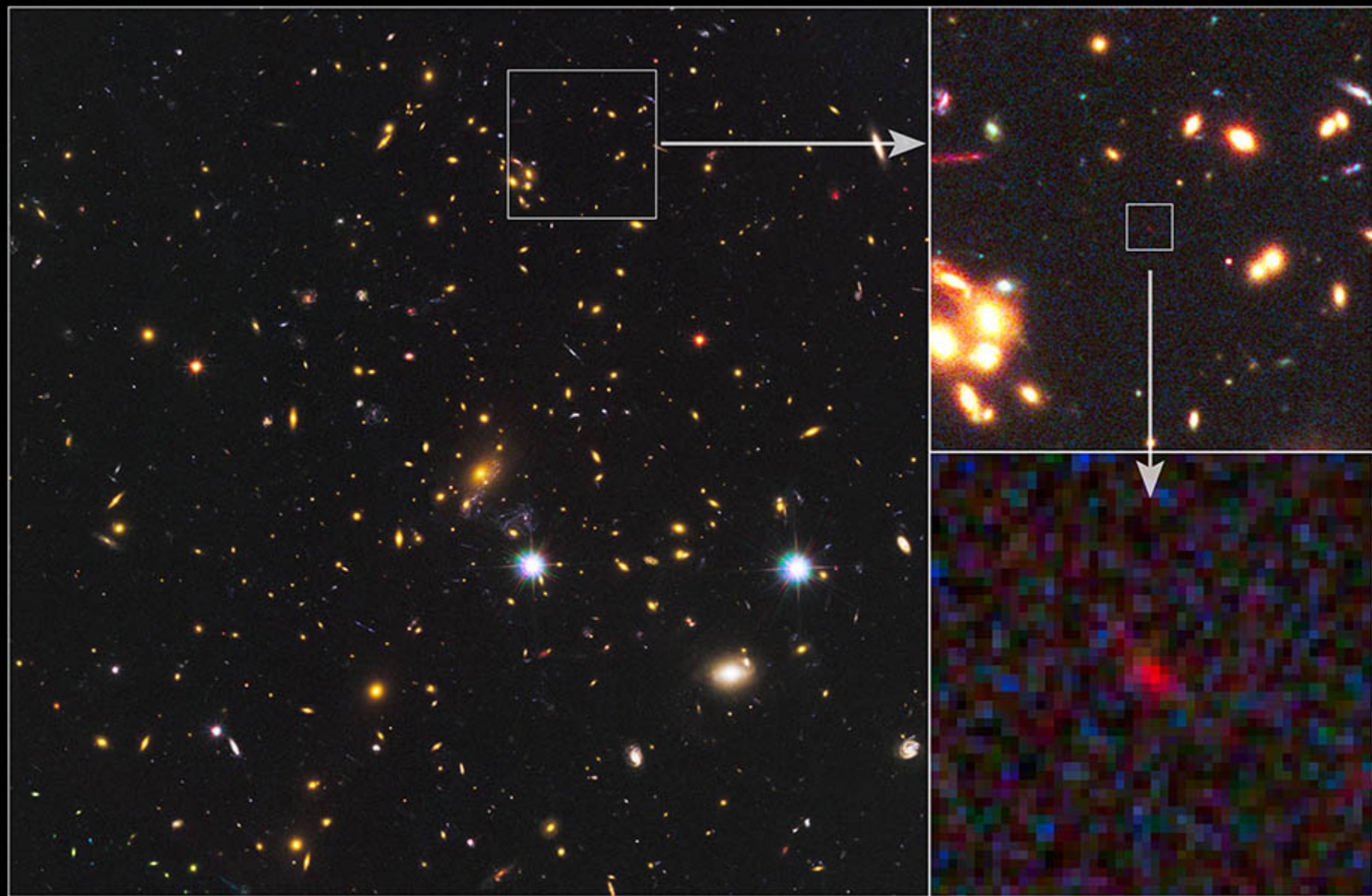


1.4

stars per 100 billion cubic light-years



Credit: X-ray: NASA/CXC/MIT/M.McDonald; UV: NASA/JPL-Caltech/M.McDonald; Optical: AURA/NOAO/CTIO/MIT/M.McDonald; Illustration: NASA/CXC/M.Weiss



Galaxy Cluster MACS J1149+2223

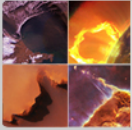
High-Redshift Galaxy MACS1149-JD

A Distant Gravitationally-Lensed Galaxy at Redshift = 9.6

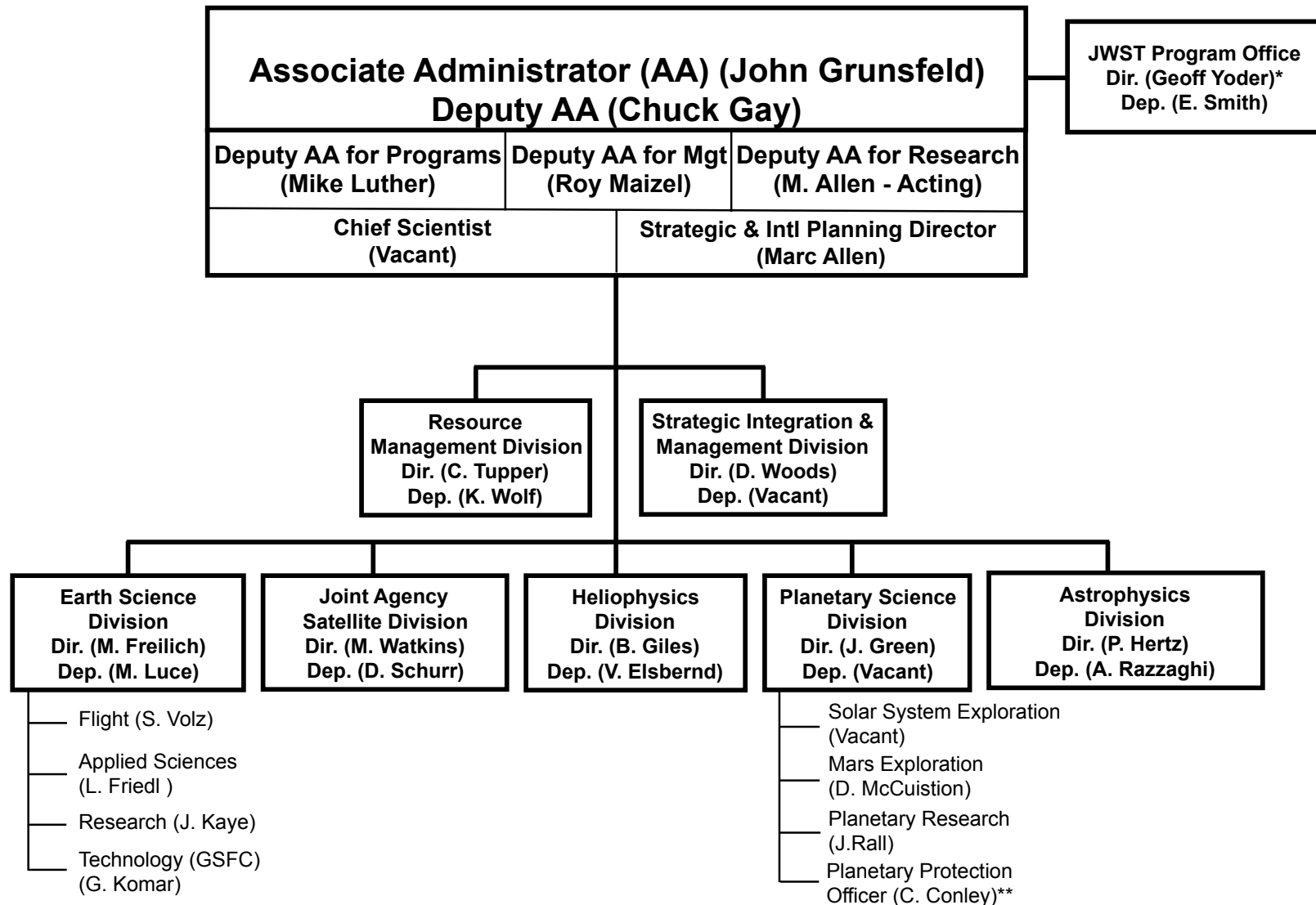
NASA / ESA / STScI/ W. Zheng (JHU), and the CLASH team

Hubble Space Telescope • ACS • WFC3

ssc2012-12a



SMD Organization Chart



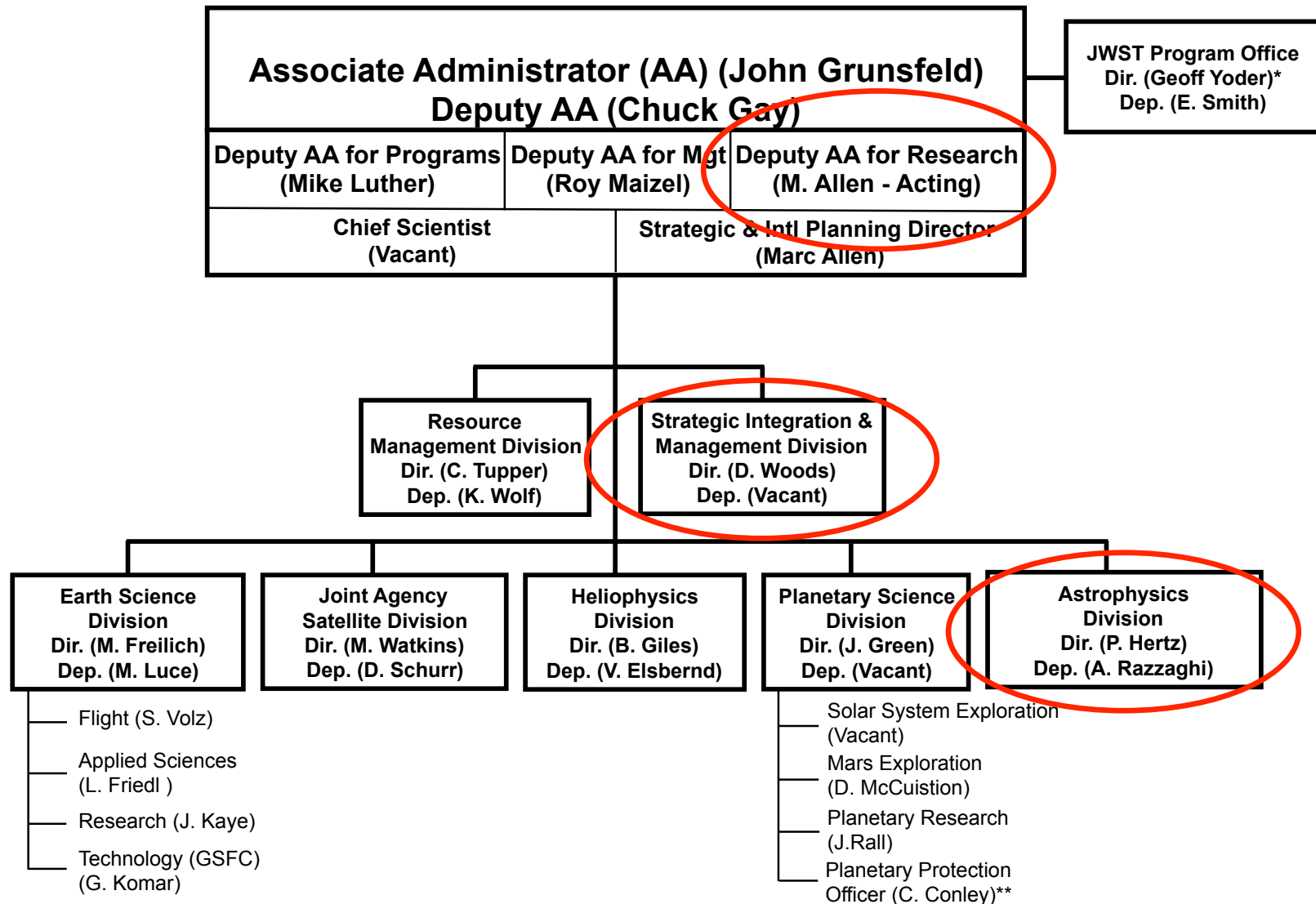
* Direct report to NASA Associate Administrator

** Co-located from the Front Office

August 2012



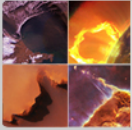
SMD Organization Chart



* Direct report to NASA Associate Administrator

** Co-located from the Front Office

August 2012



Astrophysics Division Staff Changes

- Departures

– Kelly Johnson	July 23	1-yr detail to Office of Chief Technologist
– Chris Davis	Aug 28	Left IPA for position at Liverpool
– Rita Sambruna	Sep 1	1-yr detail to Office of Strategic Formulation
– Jaya Bajpayee	Nov 1	End of detail, returns to GSFC Code 700
– Mike Moore	Nov 30	Retiring

- Arrivals

– Larry Petro	Jun 4	2-yr IPA from STScI
– Mike Garcia	Aug 1	2-yr IPA from SAO
– Christie Ashley	Aug 7	Detail from SMD Planetary Sci Division
– Keith MacGregor	Aug 20	2-yr IPA from NCAR/HAO
– Andrea Razzaghi	Sep 10	Deputy Division Director selectee
– Joan Centrella	Sep 10	1-yr detail from GSFC Code 660
– Debra Wallace	Jan 3	2-yr IPA from USCB

- Changes

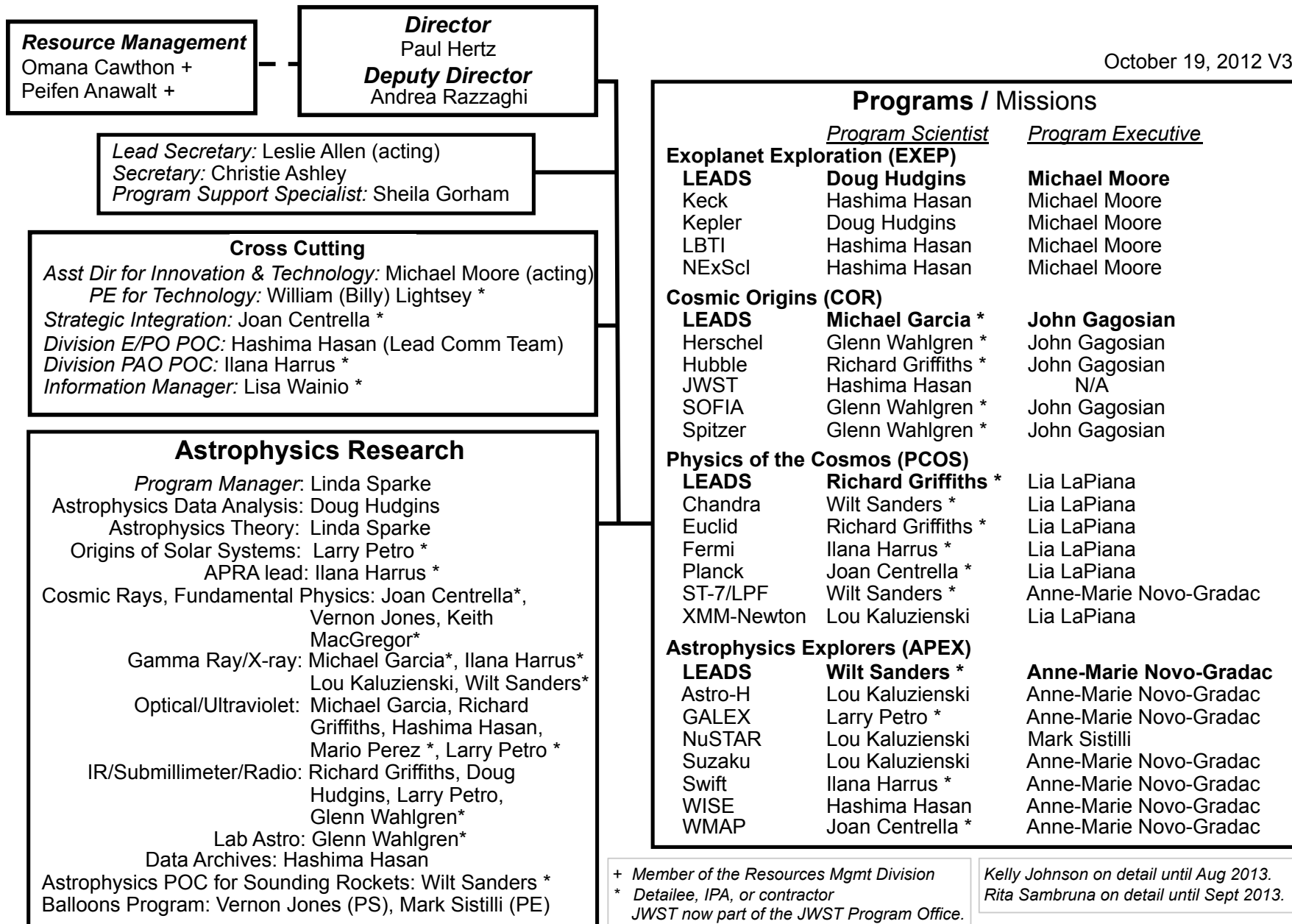
– Mario Perez	Sep 10	1-yr contract assignment, IPA ended
– Billy Lightsey	Oct 26	Detail location moved from HQ to MSFC

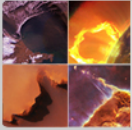
- Looking for detailees and IPAs for both PE and PS assignments



Astrophysics Division Organization Chart

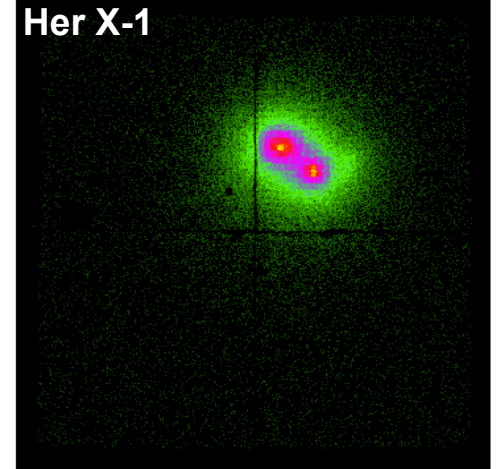
October 19, 2012 V3



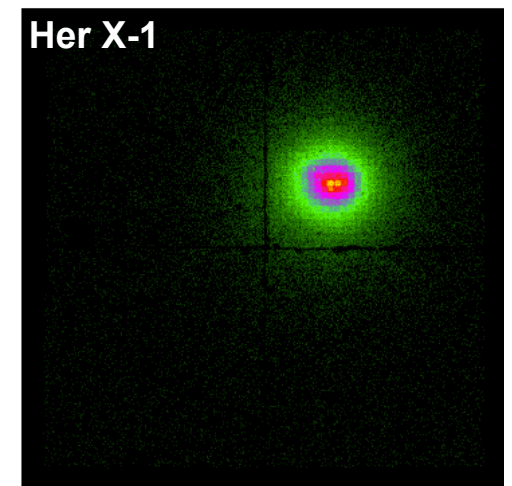


Program Update - NuSTAR

- JPL Post-Launch Assessment Review successfully completed July 24, 2012.
- 2-year Phase E started August 1, 2012.
- On-orbit science instrument calibration more complex than anticipated.
 - Unexpected thermal displacements of both the star tracker camera head units and mast structure.
 - Initial alignment was ~4mm instead of the planned 1mm.
- However, early pointing and alignment issues have now been resolved. Science observations proceeding well.
 - Full width half maximum is now <18 arcseconds.
 - Half power diameter is now <60 arcseconds.
- NuSTAR working with other missions for coordinated observations (e.g., viewing 3C273 along with Chandra, XMM-Newton, Swift, Suzaku, and INTEGRAL).
- NuSTAR PI Fiona Harrison and colleagues have submitted the first NuSTAR science paper, a letter to “Nature” on NGC1365.
- Image release on Oct 23, 2012, concerning X-ray flares at the Galactic Center.



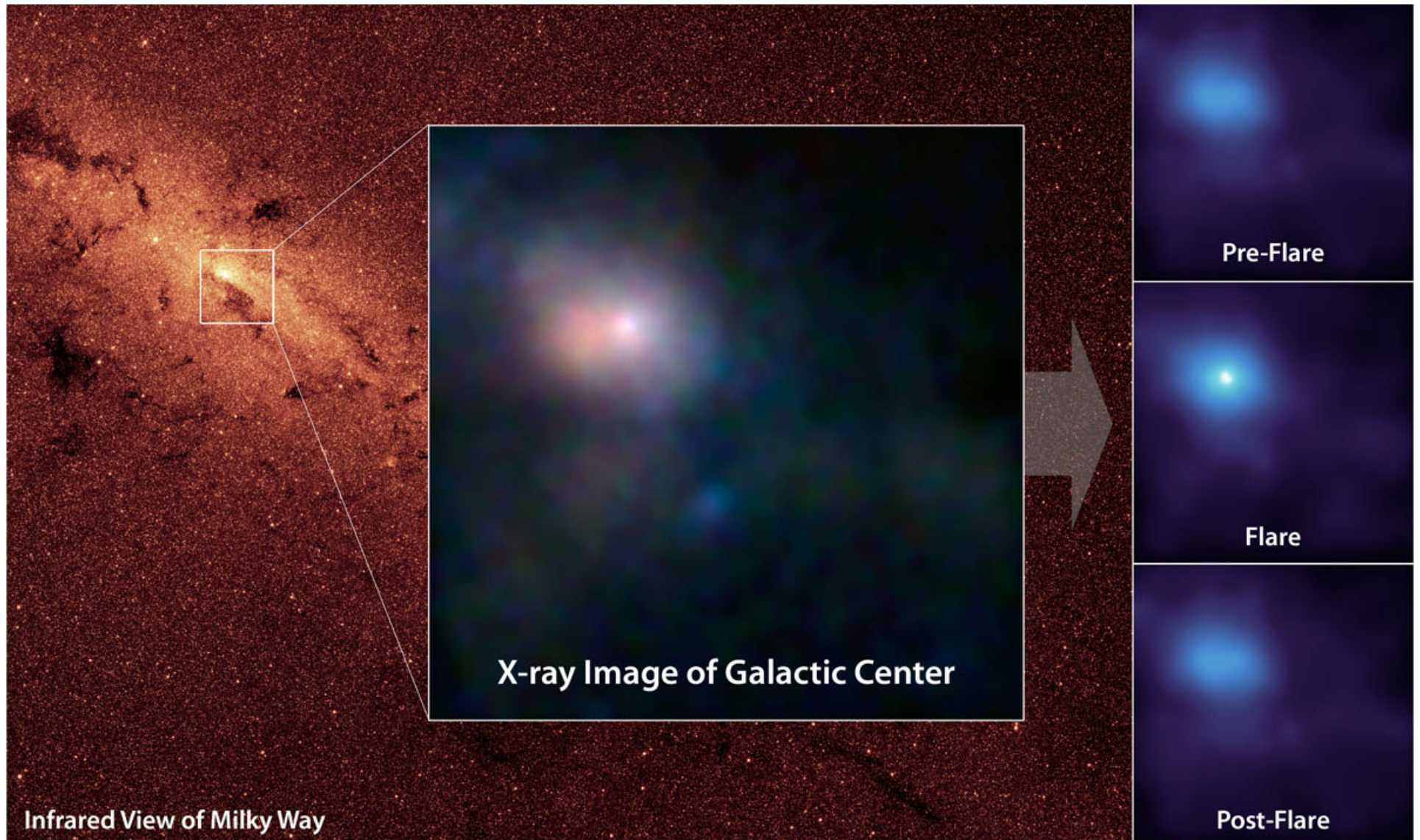
NuSTAR raw data before camera head unit alignment update - spot shifts by 4mm per orbit



NuSTAR raw data after new camera head unit alignment update 10



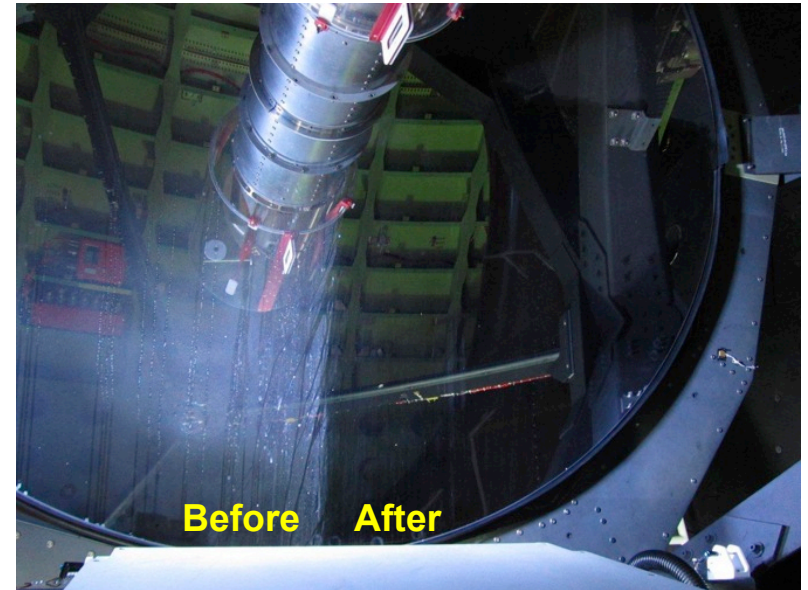
NuSTAR Galactic Center



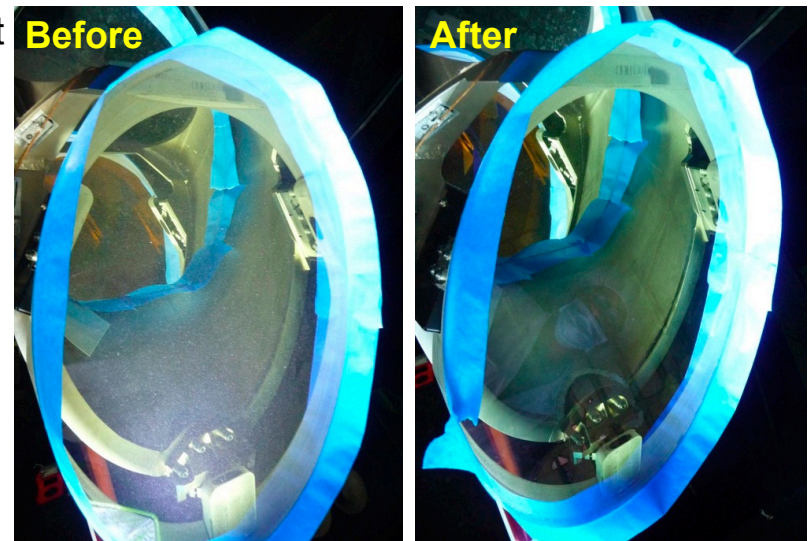


Program Update - SOFIA

- NASA accepted combined JPL + JHU/GSFC proposal for Upgraded HAWC+ instrument. PI is Darren Dowell of JPL.
- Announced Cycle 1 Science Investigations selections.
- Finishing up Segment 3 Down Time:
 - Completed installation of upgraded cockpit avionics system.
 - Completed Water Wash of telescope mirrors with significant improvement in optical properties.
 - Completed installation of Mirror Coating Facility at Dryden Aircraft Operations Facility, with first mirror recoat scheduled for August 2013.
 - Completed Ground-Based Verification and Validation testing on upgraded observatory, demonstrating significant improvements in system performance compared to 2011 Early Science campaign. In-flight V&V tests planned for November 2012. First science flight is scheduled for the first week of December.
- Upgraded Focal Plane Imager (FPI) delivered by German contractor to be installed in early CY 2013. Greater sensitivity of Upgraded FPI will improve telescope pointing performance.
- To finish planned instrument commissioning, system verification, and 200-hour general observer campaign during CY2013 will be a challenge.



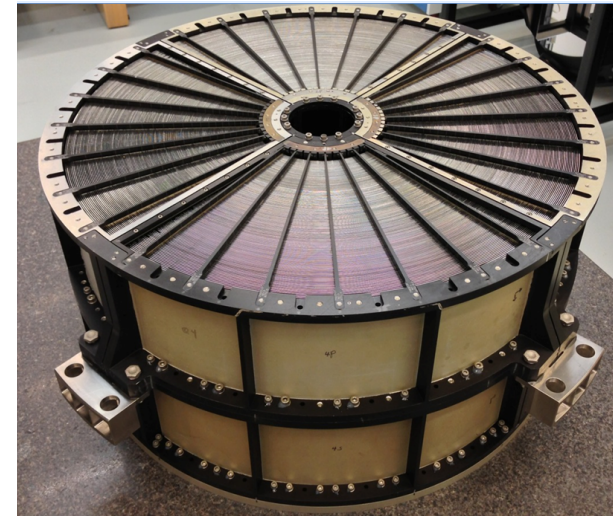
SOFIA Primary Mirror Water Wash Results



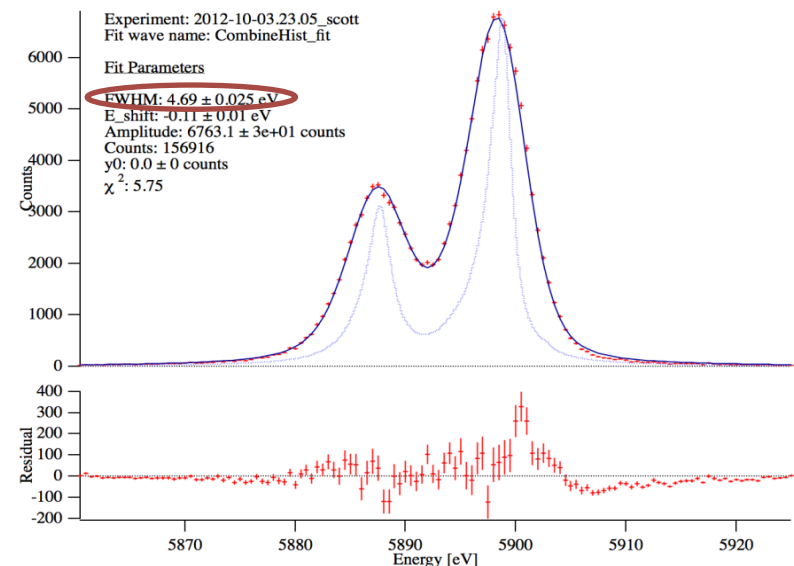


Program Update - Astro-H

- Cryogenic testing of engineering model (EM) instrument started Aug 23 and was halted Aug 31 due to a cryogen leak in JAXA EM dewar.
 - Working with JAXA to revise the I&T schedule to accommodate the dewar leak and a failed NASA heat switch, which failed during testing.
 - Heat switch recovery product team has down-selected to a new design.
- All four quadrants of the SXS mirror are complete.
- Cryogenic testing of EM instrument will resume in November/December after completion of vibration testing in early November.
- Flight model detector array is complete and has been fully characterized. Composite resolution for all 36 channels is 4.69 eV. (Requirement is 7 eV).



Astro-H SXS flight model X-ray mirror.



Resolution of Astro-H SXS flight model detector exceeds 7 eV requirement. 13



Program Update – Euclid & GEMS

Euclid

- Proposals received August 31 for NASA-selected members of the Euclid Science Team, Euclid Consortium, and Euclid Consortium Board. Selection in process.
- ESA signed a non-recurring engineering (NRE) contract with Teledyne in Aug.
- JPL and ESTEC managers have begun work on Joint Project Implementation Plan.
- ESA/NASA Bilateral held in Oct.
- MOU between NASA and ESA is in concurrence cycle. To be signed in Dec following ESA Council meeting.

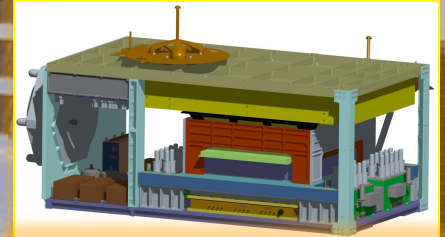
GEMS

- Termination letter sent to GSFC Sept 10, 2012.
 - Close out plan received at HQ for review and approval.
 - Lesson Learned report received at HQ.
 - Closeout will be completed by Dec 31, 2012.

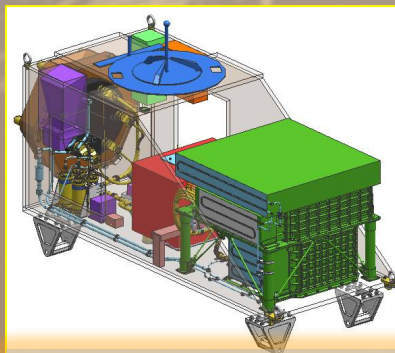
Astrophysics on the ISS: A Cosmic-ray Observatory



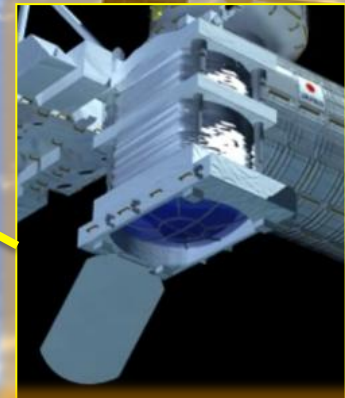
AMS Launch
May 16, 2011



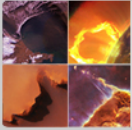
ISS-CREAM
Sp-X Launch 2014



CALET on JEM
HTV Launch 2014

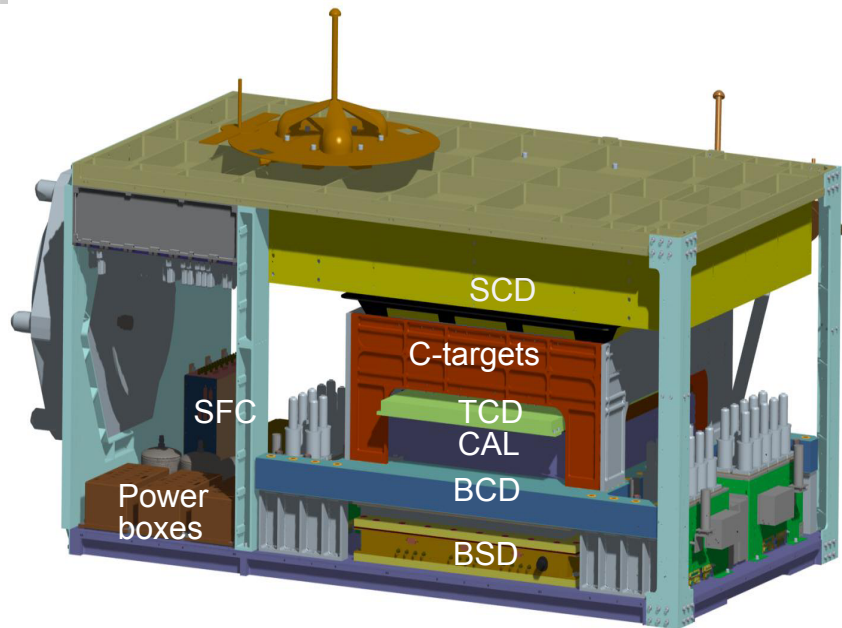


JEM-EUSO
Launch Tentatively
planned for 2017

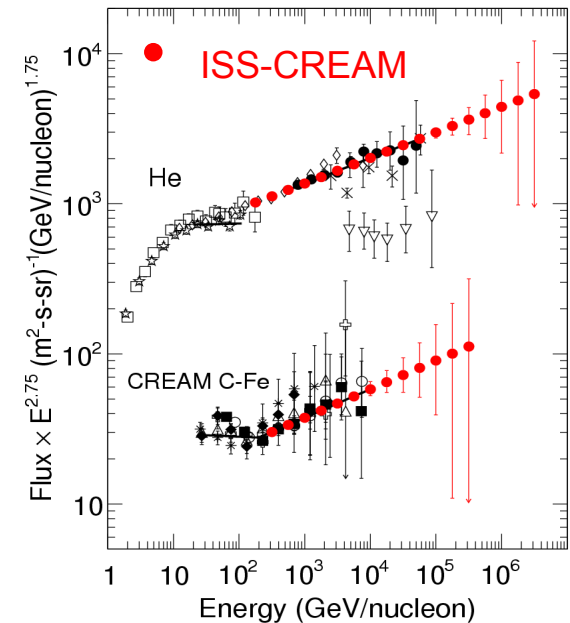


Cosmic Ray Energetics And Mass for the ISS (ISS-CREAM)

US-led NASA Mission planned for launch in 2014 by Space-X CRS 5



Mass: ~1200 kg
Power: ~ 600 W
Nominal data rate: ~350 kbps



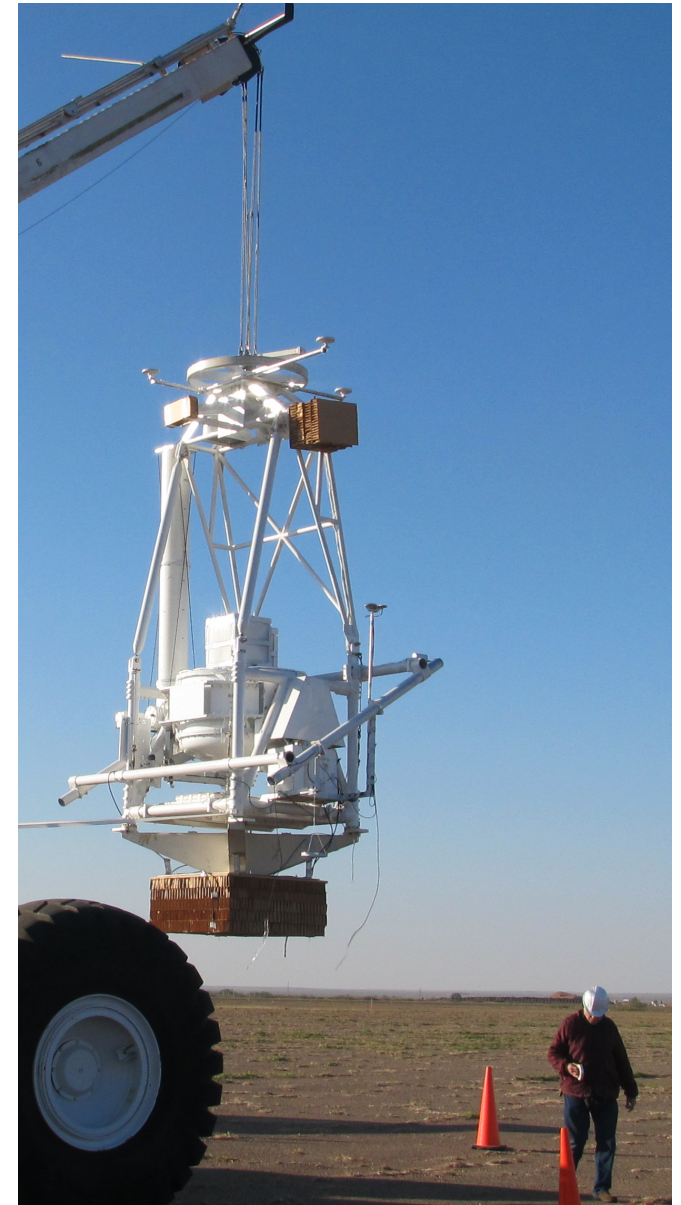
- ISS-CREAM was selected in response to a ROSES-10 proposal to repackage a balloon-borne instrument for accommodation on the ISS/JEM-EF.
- ISS-CREAM will measure cosmic ray energy spectra from 10^{12} to $>10^{15}$ eV with individual element precision over the range from protons to iron to:
 - Probe cosmic ray origin, acceleration and propagation.
 - Search for spectral features from nearby/young sources, acceleration effects, or propagation history.
- The instrument design and functionality were proven with 6 successful balloon flights around Antarctica that accumulated 161 days of exposure.



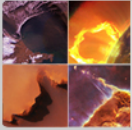
Program Update - Balloon Program

Sweden and Ft. Sumner campaigns completed.

- Successfully flew the first 18.8 MCF **super-pressure balloon** to 111,200 ft over Sweden. 8-13-2012
- **HASP** (High Altitude Student Experiment Platform)/LSU/Guzik payload. 9-1-2012.
- **ASTRA** (Analog Site Test Bed for Readiness Advancement)/JPL/Kobie. Planetary engineering payload that tested instruments (e.g., anemometers, gas chromatographs) that could have future applications on Mars. 9-9-2012.
- **SF-490**/WFF/Fairbrother engineering test flight using new balloon film. 9-13-2012.
- **WASP** (Wallops Arc-Second Pointer)/WFF/Stuchlik engineering payload test flight of arc-second pointer capable handling a 1-meter diameter telescope. 9-22-2012.
- **ProtoEXIST** (prototype hard X-ray Imager Survey Telescope)/Harvard Univ./Grindlay first test flight of the high resolution wide-field hard x-ray imager telescope and also test bed for advanced large area fine imaging CdZnTe detectors. 10-10-2012.



ProtoEXIST payload



Astrophysics Focused Telescope Assets (AFTA) Study

- **Seven month study planned to assess the use of the 2.4m telescope to implement a NWNH mission to accomplish the WFIRST science**
 - Study starts in October 2012 and is completed by May 2013.
 - GSFC leads study and is responsible for mission systems, spacecraft, instrument carrier, and wide-field instrument. JPL provides telescope management and engineering support.
 - The observatory is modular to reduce I&T costs and preserve the possibility of on-orbit evolution through commercial servicing.
 - Development schedule and cost estimate to be developed.
 - Study to include an option to add a coronagraph for exoplanet science as an example of a secondary instrument.
- **Science Definition Team formed to support study activities.**
 - Co-Chairs, David Spergel (Princeton U.) and Neil Gehrels (GSFC).
 - 1st face-to-face meeting Nov 19-20 at GSFC.
 - 2nd face-to-face meeting at AAS/Long Beach (Jan 10) and IPAC/Pasadena (Jan 11).
 - 3rd face-to-face meeting March 14-15, 2013 at GSFC.
 - SDT report, which includes a Design Reference Mission (DRM) due April 30, 2013.
- **HQ Aerospace CATE/ICE on AFTA-WFIRST DRM, due by May 30, 2013.**



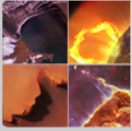
AFTA: Mock up of the 2.4m telescope at GSFC





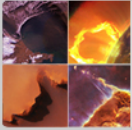
Broad Study for Other Uses of Telescope Assets

- Meet objectives in Strategic Guidance Memo of 13 August 2012:
 - “SMD will lead a broad study to assess a range of potential uses of these assets across SMD portfolio . . . beyond Decadal priorities to include NASA strategic priorities. These include integration with HEOMD and Space Technology as active partners, taking into account higher risk mission architectures, advanced technologies, and lower cost.”
- Strategies
 - Engage SMD, HEOMD, and STP in all phases of planning, execution, and wrap-up
 - Solicit the external world as broadly as possible to maximize access to original thinking
 - Utilize the technical resources across the Agency to
 - Optimize study output quality
 - Foster buy-in for the process and outcomes



Broad Study for Other Uses of Telescope Assets

1. Broadly solicit abstracts for mission concepts
2. Select abstracts received for those that best address Agency intent:
 - Highest value to science, human spaceflight, and space technology
 - Innovation
 - Cross-cutting value across directorate objectives and programs
 - Make good use of Agency capabilities, current and future
3. Workshop for by-invitation presentation and discussion of selected abstracts
4. Select presentations subset for the best value and feasibility
5. Design studies by Center mission design labs
6. Integration of final report for consideration in FY15 budget development



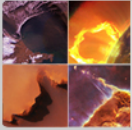
Explorer Program

- FY13 budget request does not support an AO for both missions and missions of opportunity (MOs) in late CY12.
 - First priority in the Explorer program is to complete Explorers in development: NuSTAR, SXS/Astro-H.
 - Second priority is to downselect and fund the development of one mission and one Mission of Opportunity (MO) from the projects currently conducting Phase A studies (FINESSE/TESS, GUSSTO/NICER).
 - Third priority is to issue new AOs leading to the development of additional missions.
- Funding planned for GEMS will remain in the Explorer Program.
 - Immediately begin the new projects when they are downselected in Spring 2013.
 - Advance the next mission AO.
- The Astro2010 Decadal Survey that “NASA should support the selection of two new astrophysics MIDEX missions, two new astrophysics SMEX missions, and at least four astrophysics MoOs over the coming decade.” Astrophysics Division is planning a series of AOs (subject to budget approval):
 - An AO for an MO with a \$50-60M cost cap in Sept 2012; proposals due Dec 14, 2012.
 - An AO for a SMEX in late-2013/early 2014 with the cost caps and dates TBD.
 - An AO for an EX and MO in 2015.



Program Update - VAO

- Joint NSF/NASA peer review of VAO Project Execution Plan (PEP) was held in June 2012.
 - Four technical areas (standards and infrastructure, science applications, operations, user support), plus management were reviewed.
- The results of the current review and the one held in 2011 indicate that the PEP falls short of the goal to move towards “a working observatory, which places its priority on delivering data to the research and education communities to support their activities, including further development of standards and interfaces only to the limited extent needed to stay current.”
- Together with NSF, we plan to terminate the existing VAO project at the end of FY2014 (end of its current cooperative agreement).
 - Budget reduced from NSF \$4M + NASA \$1.5M to \$2M NSF + \$1M NASA (FY13); NSF \$1M + NASA \$0.5M (FY14)
 - Closeout activities will concentrate on documenting and packaging all existing products, middleware, protocols, tools and other results, so as to be of the greatest use to any successor activity.
- We are examining models that will maximize the use of NSF and NASA resources to achieve the ultimate goal of maintaining a virtual observatory, maintaining the successful protocols and standards, that is an important research resource for our scientific community.



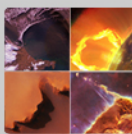
Program Update – LBTI & Keck

LBTI

- Sept 21–25, 2012, an LBTI commissioning run achieved several milestones with the Universal Beam Combiner operated at ambient temperature:
 - Automated control of the wavefront sensors
 - First sky data from the Phase Camera fringe tracker subsystem
 - First (open-loop) nulling on the sky
- Upcoming events:
 - Oct 29, 2012, four commissioning nights at ambient temperature began
 - Late 2012. Revisit Level 1 requirements in PLRA
 - Early 2013, conduct Operational Readiness Review

Keck Observatory

- Keck Observatory Archive (KOA) - In addition to the data from HIRES and NIRSPEC, all legacy data and instruments are being ingested into the KOA. The public releases for these additional data will begin in September 2013 for LRIS, November 2013 for MOSFIRE, January 2014 for DEIMOS, February 2014 for ESI, April 2014 for OSIRIS, and May 2014 for NIRC and LWS.
- Keck Cooperative Agreement – In April, NASA requested a proposal from Keck Observatory to renew the Cooperative Agreement for an additional five years (to Feb 2018). The proposal was peer-reviewed by an expert panel. Based on this, a selection was made negotiations are in progress for the Keck Observatory to execute a science program on behalf of NASA.



Astrophysics ROSES Selection Statistics

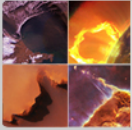
Status as of October 25, 2012

	Due Date	Notification	Days	Weeks	Rec'd	Selected	Success
			from due date	past review			
ROSES-2012							
Astrophysics Theory	13-Jul-12		104	0	182 →		
Origins of Solar Systems	25-May-12	18-Oct-12	146	8.1	46 ↑	12	26%
Astrophysics Data Analysis	18-May-12	17-Sep-12	122	4.3	291 →	90	31%
ROSES-2011							
Strategic Astrophysics Technology	23-Mar-12	30-Aug-12	160	11.6	48	8	17%
Astrophysics Research and Analysis	23-Mar-12	3-Aug-12	133	8.0	162 →	45	25%
Elements with NEW STARTS IN FY13	weighted mean =		129	6.2	501	129	26%
Fermi Guest Investigator -- Cycle 5	20-Jan-12	1-May-12	102	4.6	224 →	67	30%
Kepler Guest Observer - Cycle 4	20-Jan-12	27-Apr-12	98	3.1	61 ↑	21	34%
Roman Technology Fellowships	18-Nov-11	7-Mar-12	110	7.5	16	3	19%
Swift Guest Investigator -- Cycle 8	28-Sep-11	21-Dec-11	84	1.6	152 →	32	21%
Astrophysics Theory	3-Jun-11	28-Oct-11	147	6.2	197 →	33	17%
Origins of Solar Systems	27-May-11	7-Oct-11	133	7.1	36 →	5	14%
Astrophysics Data Analysis	20-May-11	29-Sep-11	132	6.1	278 ↑↑	60	22%
ROSES-2010							
Strategic Astrophysics Technology	25-Mar-11	31-Aug-11	159	9.0	56 ↑↑	18	32%
Astrophysics Research and Analysis	25-Mar-11	31-Aug-11	159	9.0	166 ↑↑	40	24%
Elements with NEW STARTS IN FY12	weighted mean =		126	5.6	1186	279	24%
Core (Non-GO) solicitations			143		959	198	21%
Guest Observer solicitations			95		437	120	27%



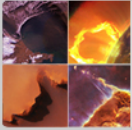
Mission Proposal Selection Rates

Mission	Number of Proposals	Number of Proposals Selected	Oversubscription Rate (time available)
Hubble (Cycle 20)	1090	230	6
Chandra (Cycle 14)	672 (452 GO, 78 Large, 17 X-ray Vision, 72 Archive, 53 Theory)	185 (144 GO, 12 Large, 4 X-ray Vision, 17 Archive, 8 Theory)	5.3
Spitzer (Cycle 9)	61 (>100 hrs) 139 (<100 hrs)	14 TBD	5.6 5.9
SOFIA (Cycle 1)	172 (133 U.S. + 32 German)	49	5
Suzaku (Cycle 7)	83 (U.S. only) 227 (Total)	46 (U.S. only) 125 (Total)	3.5
XMM-Newton (AO-11)	175 (U.S. PI-only) 501 (Total)	63 (U.S. PI-only) 179 (Total)	6.7



PCOS SAT Selections

PI	Title	Description
Will Zhang	"Next Generation X-ray Optics: High Resolution, Light Weight, and Low Cost"	... raising to TRL 5 thin glass foil x-ray optics with large collecting area ($> 1 \text{ m}^2$) at moderate angular resolution (5" - 10")
Caroline Kilbourne	"Demonstrating Enabling Technologies for the High-Resolution Imaging Spectrometer of the Next NASA X-ray Astronomy Mission"	... advance basic TES X-ray micro-calorimeter to TRL 5, including larger arrays, high energy resolution at large event rates, position sensitivity...
Jeffrey Livas	"Telescope for a Space-based Gravitational Wave Mission"	... testing a telescope for use in precision interferometry in gravitational wave missions, emphasizing dimensional stability, low stray light levels, and easy manufacturability.
John Ziemer	"Colloid Microthruster Propellant Feed System for Gravity Wave Astrophysics Missions "	... advancing to TRL 5 a new propellant storage tank and feed system for the colloidal microthrusters to increase lifetime and add redundancy needed for a LISA-like mission.
John Lipa	"Advanced Laser Frequency Stabilization using Molecular Gasses."	... advancing to TRL 4+ the development of laser frequency stabilization for space applications that require high absolute frequency stabilization and very low noise.



COR SAT Selections

PI	Title	Description
Kunjithapatham Balasubramanian (JPL)	“Ultraviolet coatings, materials and processes for advanced telescope optics”	Extensive testing of fluoride materials (CaF ₂ , LiF, MgF ₂ , LaF ₃ , AlF ₃ , etc) by using different processes to increase reflectivity in the deep UV (shorter to 120 nm), to develop a database of applicable materials, and to test the durability of these coatings.
Jonas Zmuidzinas (Caltech)	“Kinetic Inductance Detector Imaging Arrays for Far-Infrared Astrophysics”	Advance the readiness of Kinetic Inductance Detectors (KIDs) and Titanium-Nitride (TiN) films to meet the needs for large-format imaging and polarimetry.
Selmer Anglin (Teledyne Scientific & Imaging)	“Improvement of the Performance of Near-Infrared Detectors for NASA Astrophysics Missions: Reducing the Sub-1% Detector Effects”	Reduce or eliminate the image persistence (latency) which become limiting for certain applications in imaging and spectroscopy. The origin of this persistence is associated with interface defect states in the HgCdTe diode passivated surface.
Bernard Rauscher (NASA/GSFC)	“H4RG near-IR detector array with 10 micron pixels for the Wide Field Infrared Survey Telescope (WFIRST) and Space Astrophysics”	Develop 4Kx4K pixel (16 megapixel) Hawaii –4RG NIR detector arrays having 10 micron pixels for space astronomy applications, such as WFIRST mission requirements.



Examples of 2012 Communications

Created new
Astrophysics-
only mailing List
in NSPIRES

- Jan 11 - AAS Town Hall Meeting (Austin, TX)
- Jan 7-8 - ExoPAG Meeting (Austin, TX)
- Jan - New World News (Exoplanet Exploration Program Newsletter)
- Feb - Solicited members for Euclid Science Team
- Mar - Physics of the Cosmos Newsletter
- Apr - New World News (Exoplanet Exploration Program Newsletter)
- Apr 19 - Open Letter to Exoplanet community (issued through ExoPAGannounce email list)
- May 11 - Astronomy and Astrophysics Advisory Committee Meeting
- Jun 4-6 - Committee on Astronomy and Astrophysics Meeting
- Jun 12 - AAS Town Hall Meeting (Anchorage, AK)
- Jun - Cosmic Origins Newsletter
- Jul 23 - NAC Science Committee Meeting
- Jul 30-31 - Astrophysics Subcommittee Meeting
- Aug 10 - X-Ray and Gravity Wave CST reports released to community
- Aug 14-16 - Physics of the Cosmos Program Analysis Grp Workshop
- Aug - Solicited SDT members for study of 2.4m Telescope Assets
- Sept 11 - 'Future NASA Mission Opportunities in X-ray Astronomy', talk at AIAA.
- Sept 18 - COR RFI#1, 'Science Objectives for Next UV/Visible Mission' workshop
- Sept 18-19 - APRA/SR&T UV/Visible PI Workshop
- Sept 19 - COPAG meeting
- Sept 28 - Proposers workshop for 2012 Mission of Opportunity (WebEx)
- Oct 13-14 - ExoPAG Meeting (Reno, NV)
- Oct - Solicited new NAC-APS members
- Nov - Call for new IPA applications
- Dec 11-12 - APRA/SR&T IR/Submm PI Workshop



Education and Public Outreach

Here, There, and Everywhere

Here.
On Earth, all around you.

There. **Everywhere.**

HOME. TOPICS. ACTIVITIES. MULTIMEDIA. EXHIBITS. PRESS. ABOUT.

TOPICS.

The physical processes of our natural world are on constant display. They shape our surroundings on scales large and small. Across the Universe, Nature does the same.

This series of postcards helps us better understand cosmic phenomena by looking and studying what we see close to home. BECAUSE WHAT HAPPENS HERE, HAPPENS THERE, AND EVERYWHERE.

WHEN ATOMS COLLIDE.
Atoms, the building blocks of matter, are constantly in motion, moving around at speeds that are thousands of miles per hour at room temperature, and millions of miles per hour behind a supernova shock wave.

LIGHT THAT DOES NOT PASS.
You are relaxing with a book on a nice sunny day when a friend leans over your shoulder and the page goes dark. "Hey, you're blocking my light!" Any time an object blocks the light from another source, it forms a shadow.

OPEN 24 HRS

WHERE THE WIND BLOWS.
On Earth, winds can blow briefly during a storm, and over long time scales, as in the jet stream. Winds have also been detected on other planets, in the space between stars, and in galaxies.

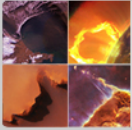
THE FLOW OF ELECTRIC CHARGE.
Electric discharge can occur wherever there is a large build-up of electric charge, and can create spectacular displays of sudden energy release on Earth and in space.

WATCH A VIDEO
READ A BLOG
ASK US A QUESTION
SHARE WITH A FRIEND

search Go

NASA

- Traveling exhibit launched at Memphis Public Library. Will tour 30 other sites through 2015.
 - Feb 2013 - Prince George's County Memorial Library, Hyattsville, MD.
- Exhibit looks at how our knowledge of familiar processes can be applied to help us understand similar behavior on grander scales, and in very different environments.
- Developed by Chandra X-ray Center under proposal NNX11AH28G.



Action Items from APS Letter – Feb 2012

Item	APS action language from letter	APD response and status
Feb 2012 Strategy	We recommend more discussion on this topic [strategic direction] at the next face-to-face APS meeting.	This was discussed at the July 2012 APS meeting. Closed.
Feb 2012 Mid-decade Review	It is not appropriate to reevaluate the science priorities of Astro2010 mid-decade. However a reassessment of the tactics to carry out Astro2010 priorities seems warranted. The APS recommends that NASA charge the mid-decade review accordingly.	On hold until the mid-decade review is chartered.
Feb 2012 R&A	Within the tight budget constraints, the APS recommends that APD allocate funds in the R&A programs in a way that responds to the Astro2010 call for augmentations to the Astrophysics Theory, Laboratory Astrophysics, and Suborbital programs. APD should balance proposal pressure across the R&A program, taking into account proposal pressure expressed in numbers of both submissions and resulting award rates.	R&A selection rates and proposal pressure is presented at every APS meeting for APS comment and recommendations.
Feb 2012	The APS urges that these competitive EPO programs (EPOSS and ROSES supplements) be re-instituted in future years at the FY11 level of funding.	This is an SMD issue and is not with the Astrophysics Director's authority. Any recommendation must be formally rewarded to the Science Committee for consideration. Closed.

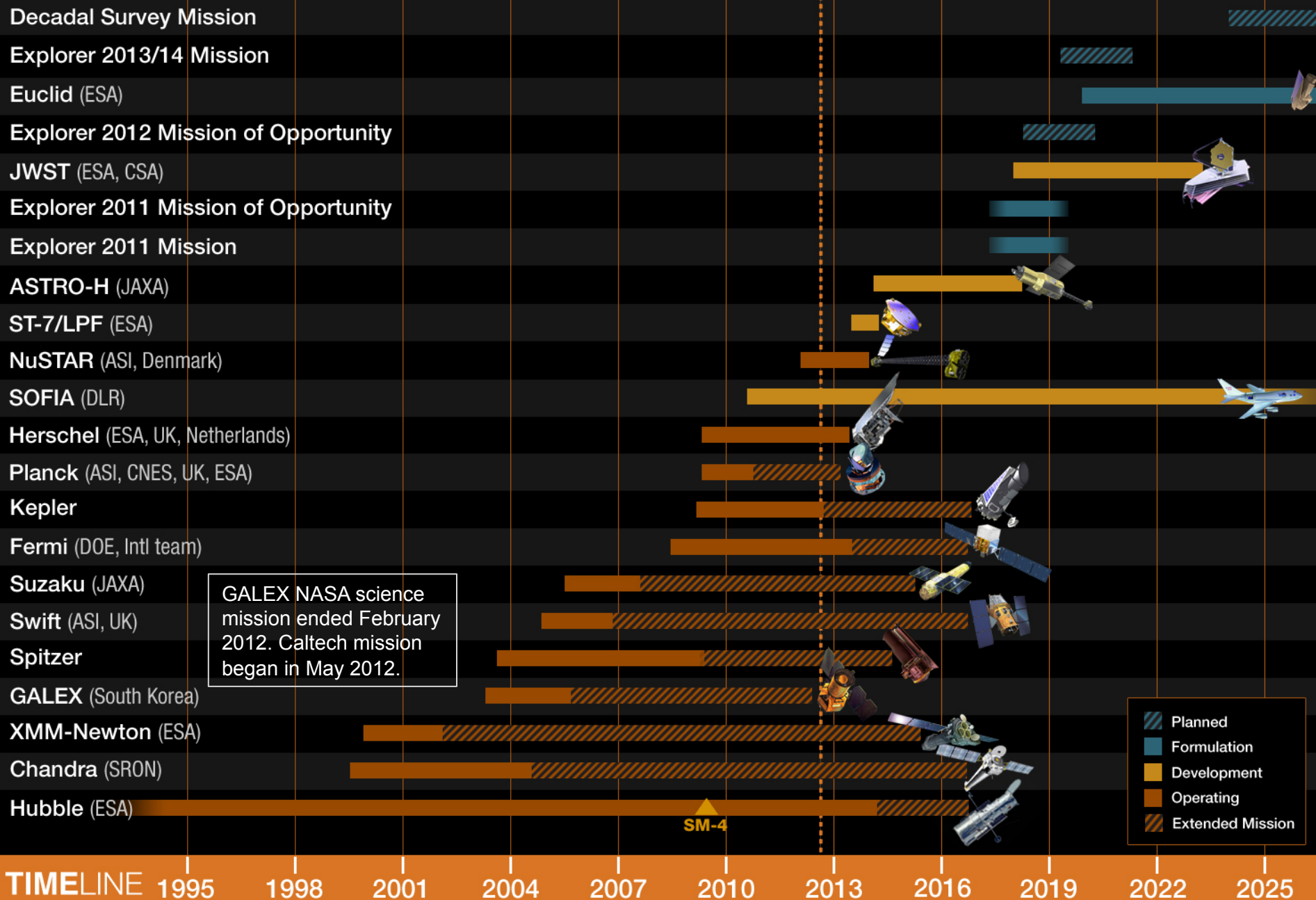


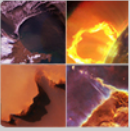
Action Items from APS Letter – July 2012

Item	APS action language from letter	APD response and status
Jul 2012 Explorers	APS would like to have a presentation at its next face-to-face meeting on the question of possibly raising the maximum cost limit for Explorer missions.	Planned for Feb/Mar 2013 meeting of the APS, prior to establishing SMEX cost cap.
Jul 2012 Explorers	The APS recommends that NASA look at shifting more funding to earlier phases [of Explorer missions] for the sake of obtaining higher-fidelity mission cost estimates as early in the process as possible.	Further explanation and discussion is required before the Astrophysics Division can respond to this issue.
Jul 2012 Strategy	The APS requests that the division director share his thinking on the [strategic] process as it evolves.	Planned for this Nov 2012 meeting of the APS.
Jul 2012 2.4m Telescope Assets	The APS requests the opportunity to comment on how the study [of the use of the 2.4m telescope assets] will be done once NASA begins to develop its plan for the study.	Planned for this Nov 2012 meeting of the APS.
Jul 2012 Mission Cost Estimates	The APS wishes to follow-up this issue [best practices of mission cost estimation and cost containment] with the Astrophysics Division director at a future meeting and recommends that the director present a summary of NASA's current "best practices" cost analysis process at the next (non-telecon) meeting.	Planned for Feb/Mar 2013 or Summer 2013 meeting of the APS.

Astrophysics Missions timeline

Last updated: October 1, 2012





Backup Slides



Astrophysics - Missions in Formulation & Implementation

Project	Overall previous months				This Month					Comments
	-4	-3	-2	-1	O	T	C	S	P	
Physics of the Cosmos	G	G	G	G	G	G	G	G	G	
ST-7 (NET Apr 2014)	G	G	G	G	G	G	G	G	G	
Euclid (2020)					G	G	G	G	G	MOU completes U.S. review, ready for signing.
Astrophysics Explorer					G	G	G	G	G	
Astro-H (TBD 2014)	Y	G	G	G	Y	G	Y	Y	G	EM functional testing will resume in December.
FINESSE, TESS, NICER, GUSSTO	G	G	G	G	G	G	G	G	G	Site visits and reviews will occur in early CY2013.
Cosmic Origins	G	G	G	G	G	G	G	G	G	
SOFIA (ongoing)	Y	Y	Y	Y	Y	G/Y	G	Y	G/Y	Conducting system verification program in preparation for Dec science flights.
Exoplanet Exploration	G	G	G	G	G	G	G	G	G	
Balloon Prog (ongoing)	G	G	G	G	G	G	G	G	G	Ft Sumner conventional balloon campaign successfully completed with flight of ProtoEXIST payload.

O: Overall, C: Cost, S: Schedule,
T: Technical, P: Programmatic

G On plan,
adequate margin

Y Problems, working to resolve
within planned margin

R Problems, not enough
margin to recover



Astrophysics – Operating Missions

Mission	Launch	End Date	Phase	-4	-3	-2	-1	June	Comments
Hubble	1990-04-24	2016-09-30	Prime	G	G	G	G	G	
Chandra	1999-07-23	2016-09-30	Ext	G	G	G	G	G	
XMM-Newton	1999-12-10	2015-03-31	Ext	G	G	G	G	G	
GALEX	2003-04-28	2012-02-07	Ext	S	S	S	S	S	Space Act Agreement signed on May 14, 2012. GALEX on loan to Caltech for up to 3 years.
Spitzer	2003-08-25	2014-09-30	Ext	G	G	G	G	G	Proposal (139) received for Cycle 9 short observations.
Swift	2004-11-20	2016-09-30	Ext	G	G	G	G	G	Cycle 9 selections made. 58 investigations selected for >100 hrs each.
Suzaku	2005-07-10	2015-03-31	Ext	G	G	G	G	G	
Fermi	2008-06-11	2016-09-30	Prime	G	G	G	G	G	
Kepler	2009-03-07	2016-09-30	Prime	G	G	G	G	Y	Mitigation of reaction wheel failure is under analysis.
Herschel	2009-05-14	2013-05-14	Prime	G	G	G	G	G	
Planck	2009-05-14	2013-01-31	Ext	G	G	G	G	G	
NuSTAR	2012-06-13	2014-08-01	Prime	G	G	G	G	G	

Kepler additional info: Four quarters of Science Data (Q10-13) publicly released Oct 28. Agreement signed with Citizen Science Alliance for citizen participation in exoplanet science using Kepler data.

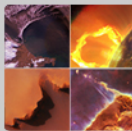
Note: End dates beyond 2014 are pending approval in the 2014 Senior Review process.

G On plan, adequate margin

Y Problems, working to resolve within planned margin

R Problems, not enough margin to recover

S Space Act Agreement. GALEX on loan to Caltech.



Astrophysics Mission Events

CY2012

2013

2014

Last Updated: October 22, 2012

Mission Launches etc.	▼ Jun 13 NuSTAR	▼ Spring Explorer10 Downselect	▼ Summer Explore12 Select	▼ Ship Flt to JAXA Astro-H	▼ CSI	▼ NET April LPF/ ST-7	▼ TBD 2014 Astro-H	▼ TBD 2014 ISS CREAM								
Suborbital <u>Rocket Program.</u>	▼ Mar C I B E R 1-3	▼ Nov I M A G E R 1	▼ Nov F O R T I S 1	▼ Dec S L I C E	▼ Dec D X L 1	▼ Mar A C C E S S 1	▼ Mar M i c r o X	▼ Sep A C C E S S 2	▼ Oct X Q C 5	▼ TBD E X O S 3	▼ TBD F O R T I S 2	▼ TBD X A C T 1	▼ TBD A C C E S S 3	▼ TBD E X O S 4	▼ TBD X A C T 2	▼ TBD A C C E S S 4
Balloon Campaigns																
Antarctica	D/J (STO, CREST)															
Sweden	J/A (Superpressure)															
Ft. Sumner (spr)																
Palestine	A/M (No astrophysics flights)															
Ft. Sumner (fall)																
Australia																
New Zealand																
Opportunities		Sept ▼ MO AO														
						</										

Cancelled due to weather. The Terrestrial Gamma-ray Flashes experiment was flown as part of the High Altitude Student Platform payload during the Fall 2012 Fort Sumner campaign.

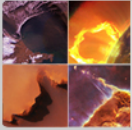


Astrophysics Research Program

	FY04 Final \$k	FY05 Final \$k	FY06 Final \$k	FY07 Final \$k	FY08 Final \$k	FY09 Final \$k	FY10 Final \$k	FY11 Final \$k	FY12 Projected
Particle Astro	\$ 8,248	\$ 7,671	\$ 8,544	\$ 7,631	\$ 6,672	\$ 8,201	\$ 8,260	\$ 8,243	\$ 8,585
High Energy	\$ 14,548	\$ 13,693	\$ 14,779	\$ 12,782	\$ 12,406	\$ 13,886	\$ 14,110	\$ 13,911	\$ 14,548
UV/Opt/IR/ Sub-mm	\$ 20,409	\$ 18,742	\$ 21,851	\$ 17,442	\$ 19,094	\$ 22,353	\$ 21,534	\$ 21,295	\$ 23,032
Other	\$ 1,019	\$ 854	\$ 338	\$ 394	\$ 594	\$ 670	\$ 673	\$ 641	\$ 1,627
APRA Total	\$ 44,224	\$ 40,960	\$ 45,511	\$ 38,250	\$ 38,765	\$ 45,110	\$ 44,577	\$ 44,090	\$ 47,791
Orig Solar Systems	\$ 4,209	\$ 3,872	\$ 4,150	\$ 3,673	\$ 2,965	\$ 3,000	\$ 2,807	\$ 2,944	\$ 2,978
Astro Theory Program	\$ 7,860	\$ 7,363	\$ 10,245	\$ 10,227	\$ 11,696	\$ 11,890	\$ 12,262	\$ 12,577	\$ 13,226
R&A (399131)	\$ 56,293	\$ 52,195	\$ 59,906	\$ 52,150	\$ 53,426	\$ 60,000	\$ 59,646	\$ 59,611	\$ 63,995
ADAP/LTSA	\$ 16,986	\$ 15,700	\$ 15,189	\$ 12,641	\$ 12,013	\$ 14,384	\$ 13,258	\$ 14,132	\$ 16,320
Core Research	\$ 73,279	\$ 67,895	\$ 75,095	\$ 64,791	\$ 65,439	\$ 74,384	\$ 72,904	\$ 73,743	\$ 80,315
TPF/FS Beyond Einstein FS	\$ 2,000	\$ 2,000		(Foundation Science; now in ATP)					
ASMCs (399131)					\$ 3,452	\$ 442			
PCOS SR&T							\$ 968	\$ 184	
Technology Fellows									\$ 600
TOTAL	\$ 79.3M	\$ 72.9M	\$ 77.1M	\$ 64.8M	\$ 68.9M	\$ 74.8M	\$ 73.9M	\$ 73.9M	\$ 80.9M
		\$7M cut	smaller cut	15% cut	partial recovery	more recovery	flat	flat	growth!

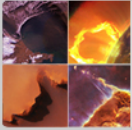
In response to the Astro2010 Decadal Survey recommendations:

- The budget for research awards increased by 10% in FY12
- Theory and Computation Networks: AAAC studying NASA-NSF program
- Suborbital program (payloads, balloons) growth deferred



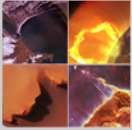
Astrophysics Program Content

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				<i>(FY14-17 estimates are notional)</i>			
Astrophysics	631.1	672.7	659.4	703.0	693.7	708.9	710.2
<u>Astrophysics Research</u>	<u>146.9</u>	<u>164.1</u>	<u>176.2</u>	<u>189.1</u>	<u>205.1</u>	<u>211.5</u>	<u>218.7</u>
Astrophysics Research and Analysis	59.6	64.6	64.2	65.5	66.8	68.2	69.5
Balloon Project	26.8	31.6	31.3	31.2	32.8	34.2	34.3
<u>Other Missions and Data Analysis</u>	<u>60.5</u>	<u>67.9</u>	<u>80.6</u>	<u>92.3</u>	<u>105.4</u>	<u>109.2</u>	<u>114.8</u>
Keck Single Aperture	2.2	2.3	2.4	2.4	2.5	2.5	2.5
Astrophysics Data Analysis Program	14.1	16.3	18.3	18.5	18.5	19.1	19.1
Astrophysics Data Curation and Archival	20.8	20.1	20.0	19.6	21.7	22.1	22.2
Astrophysics Senior Review			16.3	24.5	33.5	35.2	40.0
Education and Public Outreach	13.2	15.4	10.1	10.1	10.1	10.1	10.1
Directorate Support - Space Science	10.1	13.7	13.5	13.9	14.0	14.5	14.5
Directed Research and Technology				3.3	5.2	5.6	6.4
<u>Cosmic Origins</u>	<u>229.1</u>	<u>237.3</u>	<u>240.4</u>	<u>228.5</u>	<u>215.1</u>	<u>205.3</u>	<u>205.7</u>
Hubble Space Telescope (HST)	91.7	95.7	98.3	98.3	94.3	90.2	90.5
SOFIA	79.9	84.2	85.5	88.0	88.0	86.0	85.9
<u>Other Missions And Data Analysis</u>	<u>57.6</u>	<u>57.4</u>	<u>56.6</u>	<u>42.2</u>	<u>32.8</u>	<u>29.1</u>	<u>29.3</u>
Spitzer Space Telescope	22.7	17.8	9.8				
Herschel	24.6	24.0	20.8	15.8	5.8		
Cosmic Origins SR&T	7.9	10.6	19.4	19.5	20.7	21.7	21.8
Cosmic Origins Future Missions	0.7	1.0	1.7	1.7	1.0	2.0	2.0
Cosmic Origins Program Management	1.7	4.0	4.9	5.2	5.3	5.4	5.5



Astrophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				(FY14-17 estimates are notional)			
<u>Physics of the Cosmos</u>	<u>108.7</u>	<u>108.3</u>	<u>111.8</u>	<u>109.6</u>	<u>96.3</u>	<u>92.7</u>	<u>74.6</u>
Chandra X-Ray Observatory	60.6	54.7	56.6	56.6	56.6	56.7	51.2
Fermi Gamma-ray Space Telescope	22.3	25.3	25.0	24.5	17.5	12.9	
Planck	8.1	7.2	6.8	4.6	0.8		
XMM-Newton	1.2	2.1	1.9	1.9			
Physics of the Cosmos SR&T	13.9	15.0	14.9	15.3	15.3	16.0	16.2
Physics of the Cosmos Program Management	2.3	3.1	4.7	5.0	5.1	5.2	5.3
Physics of the Cosmos Future Missions	0.3	1.0	1.8	1.7	1.0	2.0	2.0
<u>Exoplanet Exploration</u>	<u>46.4</u>	<u>50.8</u>	<u>56.0</u>	<u>41.6</u>	<u>43.3</u>	<u>42.4</u>	<u>45.6</u>
Kepler	16.8	19.6	13.6	0.2			
Large Binocular Telescope Interferometer	1.5	2.0	3.8	2.9	2.0	0.5	0.5
Keck Operations	3.6	3.2	3.3	3.4	3.5	3.5	3.5
Keck Interferometer	0.1	0.4					
Wide Field Infrared Space Telescope	3.6						
Exoplanet Exploration SR&T	14.9	18.1	28.0	28.2	30.8	31.1	34.3
Exoplanet Exploration Program Management	4.8	6.0	6.1	5.7	5.9	6.0	6.0
Exoplanet Exploration Future Missions	1.2	1.5	1.2	1.2	1.2	1.2	1.2



Astrophysics Program Content (cont'd)

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
				<i>(FY14-17 estimates are notional)</i>			
<u>Astrophysics Explorer</u>	<u>100.0</u>	<u>112.2</u>	<u>75.1</u>	<u>134.3</u>	<u>133.9</u>	<u>157.0</u>	<u>165.6</u>
Nuclear Spectroscopic Telescope Array (NuSTAR)	36.1	11.8	4.7	4.4			
Gravity and Extreme Magnetism	23.0	63.2	46.4	32.9	2.7	0.2	
<u>Other Missions and Data Analysis</u>	<u>41.0</u>	<u>37.2</u>	<u>24.1</u>	<u>97.1</u>	<u>131.2</u>	<u>156.8</u>	<u>165.6</u>
Astro-H (SXS)	16.9	16.2	4.4	1.8	1.0	0.9	
SWIFT	6.3	4.3	4.4	4.4			
Wide-Field Infrared Survey Explorer	7.3	4.5	0.2				
Suzaku (ASTRO-E II)	1.8	0.3	0.3				
GALEX	6.2	0.6					
Wilkinson Microwave Anisotropy Pro (WMAP)	1.6	1.0					
Rossi X-Ray Timing Explorer (RXTE)	0.9						
Astrophysics Explorer Future Missions		3.1	10.6	85.6	124.0	149.6	159.3
Astrophysics Explorer Program Management		7.3	4.1	5.3	6.2	6.3	6.4